Pearson Edexcel

Mark Scheme (Results)

October 2020

Pearson Edexcel International Advanced Level
In Physics (WPH15) Paper 01
Thermodynamics, Radiation, Oscillations
and Cosmology

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Autumn 2020
Publications Code WPH15_01_2010_MS

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. **Mark scheme format**
   1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'
   1.2 Bold lower case will be used for emphasis.
   1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
   1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. **Unit error penalties**
   2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
   2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
   2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
   2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
   2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
   2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. **Significant figures**
   3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
   3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. **Calculations**

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.
4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.
4.5 The mark scheme will show a correctly worked answer for illustration only.
4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3] **3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

5. Graphs

5.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
5.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
5.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.
5.4 Points should be plotted to within 1 mm.
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.
- For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	**D is the correct answer** A is not the correct answer as paper did not absorb radiation B is not the correct answer as both aluminium and lead absorb radiation C is not the correct answer as paper did not absorb radiation	**(1)**
2	**C is the correct answer** A is not the correct answer as graph shows that low mass nuclei fusing gives less energy than when fission of massive nucleus occurs B is not the correct answer as graph shows that energy is released not absorbed D is not the correct answer as graph shows that energy is released not absorbed	**(1)**
3	**B is the correct answer** A is not the correct answer as this is the ratio of the mean squared velocities C is not the correct answer as this is the inverse of the correct answer D is not the correct answer as this is the inverse of the ratio of the mean squared velocities	**(1)**
4	**A is the correct answer** B is not the correct answer as there is a larger proportion of the total pd across the LDR C is not the correct answer as current in the circuit decreases D is not the correct answer as current in the circuit decreases and there is a larger proportion of the total pd across the LDR	**(1)**
5	**B is the correct answer** A is not the correct answer as T for the pendulum is 2.00 s not 1.00 s C is not the correct answer as incorrect value of T used and equation has not been correctly rearranged D is not the correct answer as equation has not been correctly rearranged	**(1)**
6	**D is the correct answer** A is not the correct answer as the background readings must be subtracted B is not the correct answer as the background readings must be subtracted C is not the correct answer as it is necessary to use the same time in each case	**(1)**
7	**C is the correct answer** A is not the correct answer as the relationship is not linear B is not the correct answer as a smaller thickness must cause a reduction less than 50% D is not the correct answer as the relationship is exponential	**(1)**
8	**C is the correct answer** A is not the correct answer as the mean molecular kinetic energy is unchanged B is not the correct answer as the mean molecular kinetic energy is unchanged D is not the correct answer as the mean molecular potential energy increases	**(1)**

Question Number	Answer	Mark
9	**B is the correct answer** A is not the correct answer as T is inversely proportional to the square root of k C is not the correct answer as T is inversely proportional to the square root of k D is not the correct answer as T is inversely proportional to the square root of k	**(1)**
10	**A is the correct answer** B is not the correct answer as 'normal' is not the correct description C is not the correct answer as 'optimum' is not the correct description D is not the correct answer as 'damping' is not the correct description	**(1)**

Question Number	Answer	Mark
11	Similarity: Both fields obey an inverse square law (for point masses/charges) **Or** both fields have an infinite range (1) Difference: Electric fields can be attractive or repulsive, whereas gravitational fields can only be attractive **Or** electric fields exert forces on charges whereas gravitational fields exert forces on masses (1)	**2**
	Total for question 11	**2**

Question Number	Answer	Mark
12(a)	The (massive) planet exerts a (large) gravitational force on the star. (1) The velocity of the star relative to the Earth changes. (1) (which causes a varying) Doppler shift (1)	**3**
12(b)	Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ (1) $v = 220\ \mathrm{m\ s^{-1}}$ (1) <u>Example of calculation</u> $v = \frac{3.19 \times 10^{-13}\ \mathrm{m}}{4.35 \times 10^{-7}\ \mathrm{m}} \times 3.0 \times 10^{8}\ \mathrm{m\ s^{-1}} = 220\ \mathrm{m\ s^{-1}}$	**2**
	Total for question 12	**5**

Question Number	Answer		Mark
13	(Very) high temperatures are needed to give hydrogen/nuclei/protons enough kinetic energy to overcome the repulsive force (between charges).	(1)	
	High densities are needed to enable a high enough collision rate (of nuclei to sustain the fusion reactions) **Or** High densities are needed to enable a high collision rate (of nuclei) in order to sustain the fusion reactions	(1)	
	If the material/plasma undergoing fusion (on Earth) were to touch the container the temperature would decrease and fusion would stop **Or** If the material/plasma undergoing fusion (on Earth) were to touch the container then the container would melt (and containment cease)	(1)	
	(On Earth) strong magnetic fields are required because there are containment problems for a material undergoing fusion.	(1)	**4**
	Total for question 13		**4**

Question Number	Answer	Mark
14(a)	Use of $I = \frac{L}{4\pi d^2}$ (1) $L_{\text{Sun}} = 3.9 \times 10^{26}$ (W) (1) <u>Example of calculation</u> $L_{\text{Sun}} = 4\pi \times (1.50 \times 10^{11}\text{ m})^2 \times 1.37 \times 10^3\text{ W} = 3.87 \times 10^{26}\text{ W}$	**2**
14(b)	Use of $\Delta E = c^2 \Delta m$ **and** use of $P = \frac{\Delta W}{\Delta t}$ (1) $\Delta m = 1.4 \times 10^{17}$ kg ecf from (a) (1) <u>Example of calculation</u> $\Delta m = \frac{3.87 \times 10^{26}\text{J } s^{-1} \times 3.15 \times 10^7\text{s}}{(3.0 \times 10^8\text{m s}^{-1})^2} = 1.35 \times 10^{17}\text{kg}$	**2**
	Total for question 14	**4**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>15(a)</td><td>One pair of readings taken from graph (1)

2 pairs of readings taken from graph (1)

Attempt to show that gr^2 is constant (1)

OR
Use of $F = \frac{GMm}{r^2}$ with $F = mg$ (1)

Algebra to show that $g = \frac{GM}{r^2}$ (1)

Statement that GM is constant (1)

<u>Example of calculation</u>
<table>
<tr><th>g / N kg^{-1}</th><th>r / R$_E$</th><th>g r^2 / N kg^{-1} R$_E$^{2}</th></tr>
<tr><td>8.0</td><td>1.1</td><td>9.7</td></tr>
<tr><td>5.0</td><td>1.4</td><td>9.8</td></tr>
<tr><td>2.0</td><td>2.2</td><td>9.7</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>9.8</td><td>1.0</td><td>9.8</td></tr>
<tr><td>2.4</td><td>2.0</td><td>9.6</td></tr>
<tr><td>0.6</td><td>4.0</td><td>9.6</td></tr>
</table></td><td>3</td></tr>
<tr><td>15(b)(i)</td><td>(The graph shows) g is not constant (from the surface of the Earth to height of $5R_E$)
Or the gravitational field is not uniform over this distance (1)</td><td>1</td></tr>
<tr><td>15(b)(ii)</td><td>Use of $V_{grav} = -\frac{GM}{r}$ (1)

Use of $\Delta E_{grav} = m\,\Delta V_{grav}$ (1)

$\therefore \Delta E_{grav} = 1.8 \times 10^{11}$ J (1)

<u>Example of calculation</u>

$\Delta V_{grav} = \frac{GM}{R_E} - \frac{GM}{6R_E}$

$\therefore \Delta V_{grav} = \frac{6.67 \times 10^{-11}\text{ N m}^2\text{ kg}^{-2} \times 6.0 \times 10^{24}\text{ kg}}{6.4 \times 10^6\text{ m}}\left(1 - \frac{1}{6}\right) = 5.2 \times 10^7\text{ J kg}^{-1}$

$\therefore \Delta E_{grav} = 3.5 \times 10^3\text{ kg} \times 5.2 \times 10^7\text{ J kg}^{-1} = 1.82 \times 10^{11}$ J</td><td>3</td></tr>
<tr><td></td><td>Total for question 15</td><td>7</td></tr>
</table>

Question Number	Answer	Mark
16(a)	At the top of the main sequence (1) Accept a sketch of H-R diagram with the stars correctly marked on the main sequence	**1**
16(b)	Use of $\lambda_{\max}T = 2.898 \times 10^{-3}$ m K (1) $\lambda_{max} = 9.7 \times 10^{-8}$ m (1) <u>Example of calculation</u> $\lambda_{\max} = \dfrac{2.898 \times 10^{-3} \text{ m K}}{3.00 \times 10^{4} \text{ K}} = 9.66 \times 10^{-8}$ m	**2**
16(c)	Use of $L = \sigma T^4 A$ (1) $r = 2.3 \times 10^{10}$ m (1) <u>Example of calculation</u> $5.37 \times 10^5 \times 3.85 \times 10^{26} \text{W} = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-1} \times 4\pi \times r^2 \times (2.75 \times 10^4 \text{ K})^4$ $\therefore r = \sqrt{\dfrac{2.07 \times 10^{32} \text{W}}{5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-1} \times 4\pi \times \left(2.75 \times 10^4 \text{K}\right)^4}} = 2.25 \times 10^{10}$ m	**2**

Question Number	Answer		Mark
16(d)	Use of $I = \frac{L}{4\pi d^2}$	(1)	
	$I_A = 4.6 \times 10^{-8}$ Wm^{-2} and $I_M = 3.6 \times 10^{-8}$ Wm^{-2} **Or** $\frac{I_A}{I_M} = 1.25$	(1)	
	Comparison of the intensities of the two stars and appropriate deduction. Dependent on MP1	(1)	
	OR		
	Alnilam is about 6 times as luminous as Mintaka, but Alnilam is twice as far away		
	And the intensity of a star is given by $I = \frac{L}{4\pi d^2}$ **Or** The intensity of a star is proportional to luminosity and inversely proportional to the distance squared Dependent on MP1	(1)	
	Hence the intensity of Alnilam is greater than that from Mintaka and so Mintaka has the lower intensity. Dependent on MP1 and MP2.	(1)	
	Example of calculation		**3**
	$\frac{I_A}{I_M} = \frac{L_A}{L_M} \times \left(\frac{d_M}{d_A}\right)^2$	(1)	
	$\therefore \frac{I_A}{I_M} = \frac{5.37 \times 10^5}{9.0 \times 10^4} \times \left(\frac{8.7 \times 10^{18}\ \text{m}}{1.9 \times 10^{19}\ \text{m}}\right)^2 = 1.25$		
	Total for question 16		**8**

Question Number	Answer		Mark
17(a)	Use of circumference = $2\pi r$	**(1)**	
	Use of $V = \frac{4\pi r^3}{3}$	**(1)**	
	Conversion of temperature to kelvin	**(1)**	
	Use of $pV = NkT$	**(1)**	
	Excess pressure calculated	**(1)**	
	Excess pressure is 79 kPa, so ball meets FA rules	**(1)**	**6**
	<u>Example of calculation</u> $r = \frac{0.685\text{ m}}{2\pi} = 0.109\text{ m}$ $V = \frac{4\pi}{3} \times (0.109\text{ m})^3 = 5.42 \times 10^{-3}\text{m}^3$ $p = \frac{NkT}{V} = \frac{2.5 \times 10^{23} \times 1.38 \times 10^{-23}\text{ J K}^{-1} \times (16+273)}{5.42 \times 10^{-3}\text{ m}^3} = 1.84 \times 10^5\text{Pa}$ Excess pressure = 1.84×10^5 Pa – 1.05×10^5 Pa = 7.9×10^4 Pa (79 kPa)		

Question Number	Answer	Mark
***17(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for structure and lines of reasoning.	

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

Indicative content

- As the temperature of the air decreases the average/mean kinetic energy of the molecules decreases
- So the (root mean square) velocity/speed of the molecules decreases
  Or (Since $E_k = \frac{p^2}{2m}$) the (average) momentum of the molecules decreases
- The change of momentum of a molecule during a collision with the container walls decreases
- The rate of collision of molecules with the walls of the container decreases
- So the rate of change of momentum decreases and so the force on the container walls decrease s
- Hence the pressure exerted by the gas decreases, since $p = F/A$ — **6**

	Total for question 17	**12**

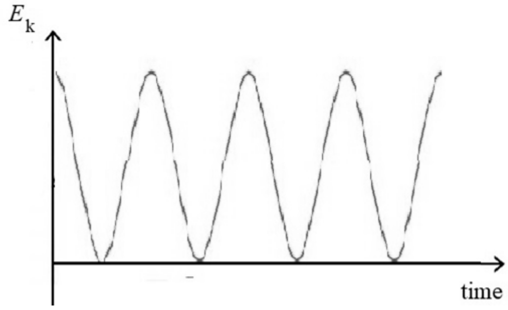
Question Number	Answer	Mark
18(a)	$^{48}_{20}\text{Ca} + ^{249}_{98}\text{Cf} \rightarrow ^{294}_{118}\text{Og} + \mathbf{3} \times ^{1}_{0}\text{n}$ (1)	**1**
18(b)(i)	Cyclotron **Or** Linac **Or** Particle accelerator (1)	**1**
18(b)(ii)	Conversion of energy to J (1) Conversion of mass to kg (1) Use of $E_k = \frac{1}{2}mv^2$ (1) $v = 3.1 \times 10^7$ m s^{-1} (1) Comparison of calculated value of *v* and *c* and valid conclusion (1) <u>Example of calculation</u> $E_k = 245 \times 10^6$ eV $\times 1.6 \times 10^{-19}$ J eV^{-1} = 3.92×10^{-11} J m = 47.95×1.66 x 10^{-27} kg = 7.96×10^{-27} kg $v = \sqrt{\frac{2 \times 3.92 \times 10^{-11}\text{J}}{7.96 \times 10^{-26}\text{ kg}}} = 3.14 \times 10^7$ m s^{-1}	**5**
18(c)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ (1) Use of $N = N_0 e^{-\lambda t}$ (1) $N_0 = 3.5 \times 10^3$ (1) <u>Example of calculation</u> $\lambda = \frac{0.693}{0.89 \times 10^{-3}\text{s}} = 779$ s^{-1} $500 = N_0 e^{-780 \text{ s}^{-1} \times 2.5 \times 10^{-3} \text{ s}}$ $N_0 = \frac{500}{0.142} = 3.50 \times 10^3$	**3**

Question Number	Answer		Mark
18(d)	Handle the source with tongs	(1)	
	As alpha particles can only travel a few cm in air [Accept alpha particles have a very short range] **Or** The greater the distance, the lower the intensity of radiation received	(1)	
	OR		
	Handle the source for as short a time a possible	(1)	
	As the ionising effect is cumulative	(1)	**2**
	Total for question 18		**12**

Question Number	Answer		Mark
19(a)	The natural frequency of the water molecule is about 10 GHz	(1)	
	The microwave radiation frequency (2.45 GHz) is not at/about the natural frequency of the water molecule and so this is not resonance **Or** The driving frequency is not is not at/about the natural frequency of the water molecule and so this is not resonance	(1)	**2**
19(b)(i)	The (rotating) water molecules collide with other molecules (in the food)	(1)	
	There is a transfer of kinetic energy to (adjacent) molecules (in the food)	(1)	
	This increases the internal energy and hence the temperature of the food **Or** this increases the (average) kinetic energy (of the molecules) and hence the temperature of the food	(1)	**3**
19(b)(ii)	Ice is a solid and so the molecules have fixed positions	(1)	
	This prevents the molecules in the solid ice from rotating **Or** only molecules in liquid water around the ice can rotate	(1)	**2**

Question Number	Answer	Mark
19(c)(i)	Use of $\Delta E = mc\Delta\theta$ and use of $P = \frac{\Delta W}{\Delta t}$ (1) Use of efficiency = $\frac{\text{useful power output}}{\text{power input}}$ **Or** Use of efficiency = $\frac{\text{useful energy output}}{\text{energy input}}$ (1) Efficiency = 56 %, so the manufacturer's claim is invalid (1) <u>Example of calculation</u> $P = \frac{0.325\text{ kg} \times 4190\text{ J kg}^{-1}\text{ K}^{-1} \times (85.0 - 25.0)\text{ °C}}{225\text{ s}} = 363\text{ W}$ efficiency= $\frac{363\text{ W}}{650\text{ W}} \times 100\ \% = 55.8\ \%$	**3**
19(c)(ii)	Energy transfer from water cooling = energy transfer to melt ice + energy transfer to heat ice (1) Use of $\Delta E = mc\Delta\theta$ (1) Use of $\Delta E = mL$ (1) θ = 59 °C (1) <u>Example of calculation</u> Energy transfer from water cooling = energy transfer to melt ice + energy transfer to heat ice $m_{\text{water}}\, c\, \Delta\theta_{\text{water}} = m_{\text{ice}}\, L + m_{\text{ice}}\, c\, \Delta\theta_{\text{ice}}$ $0.325\text{ kg} \times 4190\text{ J kg}^{-1}\text{K}^{-1}\ (85.0 - \theta)$ $= 0.0625\text{ kg} \times 3.33 \times 10^{5}\text{ J K}^{-1} + 0.0625\text{ kg} \times 4190\text{ J kg}^{-1}\text{ K}^{-1}(\theta - 0.0)$ $1362\,\theta + 262\,\theta = +1.16 \times 10^{5}\text{ J} - 2.08 \times 10^{4}\text{ J}$ $\therefore\ \theta = \frac{9.52 \times 10^{4}}{1620} = 58.8\ \text{°C}$	**4**
	Total for question 19	**14**

Question Number	Answer	Mark
20(a)	(For simple harmonic motion the) acceleration is: • (directly) proportional to <u>displacement</u> from equilibrium position (1) • acceleration is in the opposite direction to displacement **Or** (always) acting towards the equilibrium position (1) **OR** (For simple harmonic motion the resultant) force is: • (directly) proportional to <u>displacement</u> from equilibrium position (1) • force is in the opposite direction to displacement **Or** (always) acting towards the equilibrium position (1) (An equation with symbols defined correctly is a valid response for both marks For equilibrium position accept: undisplaced point/position **or** fixed point/position **or** central point/position)	**2**
20(b)	Use of $F = k\Delta x$ (1) Use of $T = 2\pi\sqrt{\frac{m}{k}}$ (1) Use of $v_{max} = \omega A$ with $\omega = \frac{2\pi}{T}$ (1) Use of $E_k = \frac{1}{2}mv^2$ (1) $E_k = 9.1 \times 10^{-3}$ J (1) **OR** Use of $F = k\Delta x$ (1) Statement that E_k max = ΔE_{el} (1) Because energy is conserved (1) Use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ with $F = k\Delta x$ (1) $E_k = 9.1 \times 10^{-3}$ J (1) <u>Example of calculation</u> $k = \frac{F}{\Delta x} = \frac{0.25\text{ kg} \times 9.81\text{ N kg}^{-1}}{0.165\text{ m}} = 14.9\text{ N m}^{-1}$ $T = 2\pi\sqrt{\frac{0.25\text{ kg}}{14.9\text{ N m}^{-1}}} = 0.814\text{ s}$ $E_k = \frac{1}{2} \times 0.25\text{ kg} \times \left(\frac{2\pi \times 3.5 \times 10^{-2}\text{ m}}{0.814\text{ s}}\right)^2 = 9.13 \times 10^{-3}\text{J}$	**5**

Question Number	Answer		Mark
20(c)	Sinusoidal curve with twice the frequency of displacement graph Always positive and maximum E_k at t = 0 <u>Example of graph</u>  	(1) (1)	**2**
20(d)	There would be viscous/drag forces on the mass as it moved through the water This would remove energy (from the oscillation) **Or** this causes damping The amplitude would decrease over time (dependent on MP2)	(1) (1) (1)	**3**
	Total for question 20		**12**

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